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Monetary valuation methods in urban ecosystem accounting

- examples of their relevance for municipal policy and planning in the Oslo metropolitan area

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The SEEA Experimental Ecosystem Accounting Technical Recommendations discuss a number of potential uses and applications of ecosystem accounting information. Using Oslo municipality as an example we discuss what types of monetary valuation methods could provide decision-support to different municipal planning and policy needs. We discuss the SNA accounting compatibility of hedonic property pricing, restoration costs, replacement cost, travel cost valuation and stated preference techniques, using the guidance criteria provided by the SEEA EEA Technical Recommendations. We find that the SEEA EEA TR guidance on monetary valuation is restrictive in terms of what information is considered SNA compatible. Our benchmark for this comparison is an assessment of what economic information municipalities or regional governments might find relevant for planning. We find that the SNA production boundary excluding household allocation of time is a serious limitation to valuing cultural ecosystem services, particularly in urban ecosystems. We also find that SEEA TR offer few guidelines on how to use economic valuation information that does not conform to SNA standards. This is in contrast to extensive recommendations on how to use biophysical indicators of ecosystem condition, and parallel thematic environmental accounts, which also currently lie outside the SNA production boundary. Applying current SEEA EEA TR 'to the letter' regarding monetary valuation risks already available and useful information falling outside an ecosystem accounting system that – for exchange values and biophysical indicators - offers great possibilities for a systematic organization of municipal environmental management. We argue that further work is needed on parallel thematic accounts. Providing a suite of ecological, accounting, welfare and socio-cultural indicators that are sought after by local governments in planning, will in time strengthen 'grassroots' support for ecosystem accounting at national level.

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Contents

- 1. Introduction..... 3
 - 1.1 The decision support role of SEEA EEA..... 3
 - 1.2 Purposes of monetary valuation in supporting municipal policy..... 4
 - 1.3 Accuracy requirements for financial and economic decision support..... 6
 - 1.4 Exchange value - valuation methods appropriate for ecosystem accounting 8
- 2. Examples – assessing the accounting compatibility of ecosystem service valuation methods in Oslo 10
 - 2.1 Hedonic pricing..... 10
 - 2.2 Marginal values from demand functions 12
 - 2.3 Contingent valuation 15
 - 2.4 Restoration cost 16
- 3. Discussion 17
 - 3.1 On hedonic pricing, amenity values and double counting 17
 - 3.2 On the exchange values of urban recreation 17
 - 3.3 On the relevance of monetary ecosystem accounting for municipal decision-making 20
- 4. Conclusions..... 21
- 5. References..... 23

1. Introduction

In this paper we discuss the recommendations of the draft SEEA EEA Technical Recommendations on the appropriate and inappropriate methods for valuation in monetary accounts. In the following we refer to SEEA-EEA 2016 draft Technical Recommendations as SEEA-EEA TR. We discuss the recommendation for valuation methods in light of the purpose of ecosystem accounting, and more specifically the purpose of ecosystem accounting for municipal level policies for urban ecosystem management. We use examples from valuation of urban ecosystem services in Oslo to illustrate the discussion.

1.1 The decision support role of SEEA EEA

What does SEEA EEA TR say about the purposes of ecosystem accounting for policy and decision support? Some general observations regarding the purpose of ecosystem accounts which are relevant for our further discussion include (recommendations from the SEEA-EEA TR are written in *italics* throughout the text) (section 1.1):

- [..]
- *at sub-national scales, the potential of ecosystem accounting can be demonstrated more easily by linking directly to the development of responses to specific policy themes or issues.*
- [..]
- *the core monetary ecosystem accounts will not provide all of the information needed to support all decision making contexts. Nonetheless, the broad information set of the ecosystem accounts, in particular accounts in physical terms, will, at a minimum, provide coherent context for all decision-making situations.*
- [..]
- *the approach increases the potential for ecosystem accounting to provide information that is highly relevant in assessing site specific trade-offs and heightens the potential for the ecosystem accounting framework to assist in organizing a large amount of existing ecological data.*

SEEA EEA TR also describes a number of specific policy and management uses of information from different accounts:

Ecosystem accounts provide several important pieces of information in support of policy and decision making relating to environment and natural resources management (section 1.1.4):

- [..]
- *Detailed, spatial information on ecosystem services supply [..]*
- *Monitoring of the status of ecosystem assets [..]*
- *Highlighting the ecosystem assets, ecosystem types and ecosystem services of particular concern for policy makers. [..]*
- *Monitoring the status of biodiversity and indicating specific areas or aspects of biodiversity under particular threat. [..]*
- *Quick response to information needs. [..]*
- *Monitoring the effectiveness of various policies.[..]*
- *Use in economic and financial decision-making. i.a. [..] to extend standard economic modelling approaches and to enhance broad indicators of economic performance such as national income, savings and productivity. While these measures and applications are different from the more common applications of ecosystem services valuations, the ability to consider ecosystems through multiple analytical lenses appears a strong motivation to continue development of valuations for accounting purposes. [..]*

Notably, only one of the seven purposes of ecosystem accounting listed in the introduction to SEEA EEA TR requires the use of monetary valuation. For economic and financial decision-support the purpose is more specifically to “extend” standard economic modeling and “enhance” broad indicators, as well as to “consider ecosystems through multiple analytical lenses”. The purpose of “monitoring” of ecosystem asset, biodiversity status and policy effectiveness is prominent, but does not necessarily require monetary valuation.

What is the decision support role of monetary accounts more specifically, including ecosystem service use, supply and asset accounts? In section 7.2 on ecosystem monetary asset accounts, the purposes are more specific. Of interest to our further discussion is to note differences in accuracy and reliability that the different purposes of monetary accounting will require.

[..] *Estimates of ecosystem assets in monetary terms are useful for making decisions about alternative uses of ecosystem assets since they provide a consistent basis for comparison. In addition, estimates in monetary terms can be integrated with valuations for other types of assets to provide more complete assessments of net wealth. A decline in value of ecosystem assets at aggregated scales (e.g. in the EAA) may point to unsustainable ecosystem use.* [..]

1.2 Purposes of monetary valuation in supporting municipal policy

Specification of the purpose of valuation can help determine the reliability and accuracy required of valuation methods, helping to select methods compatible with the decision-support requirements. Gómez-Baggethun and Barton (2013) and Schröter *et al.* (2014) discuss how different decision support purposes have different accuracy and reliability requirements for valuation and accounting methods. They argue that the decision-support purpose will determine which monetary valuation methods are suitable because of differences in their accuracy and reliability. Several broad policy support needs at municipal level are suggested in Figure 1¹.

Using this framework we can consider the different purposes of monetary accounts cited above in section 1.1. Requiring monetary accounts to identify a “*decline in value of ecosystem assets at aggregated scales*” is the least demanding of these monetary purposes as it only requires that a significant trend be observed. Comparing “*alternative uses of ecosystem assets*”, suggests screening or ranking of alternatives in terms of value. This is a purpose familiar to benefit-cost analysis, and is demanding in terms of accuracy of monetary values as net benefits of alternatives must be compared. Finally, a “*more complete assessment of net wealth*” suggests an awareness-raising purpose in demonstrating ecosystems’ economic contribution to overall societal well-being. It carries the implicit expectation that valuation methods quantify significant asset value of ecosystems. ‘Significance’ of values might be the result of a comparison with the value of assets that currently fall within the production boundary of SNA.

When discussing monetary valuation methods from Oslo below in light of SEEA EEA TR requirements, we will also try to keep these policy support purposes in mind. Do SEEA EEA TR requirements for SNA compatibility further or hamper the purposes shown in Figure 1? Furthermore, do the accounting compatibility requirements maintain a reasonable balance between (i) consistency with SNA, (ii) costs of obtaining the information, and (iii) providing information value for decisions. Providing information value for decisions concerns obtaining sufficient accuracy and reliability for the purpose at hand.

¹ based on experiences from collaborating with Oslo Municipality in the OpenNESS project <http://www.nina.no/OpenNESS> and URBAN EEA Project.

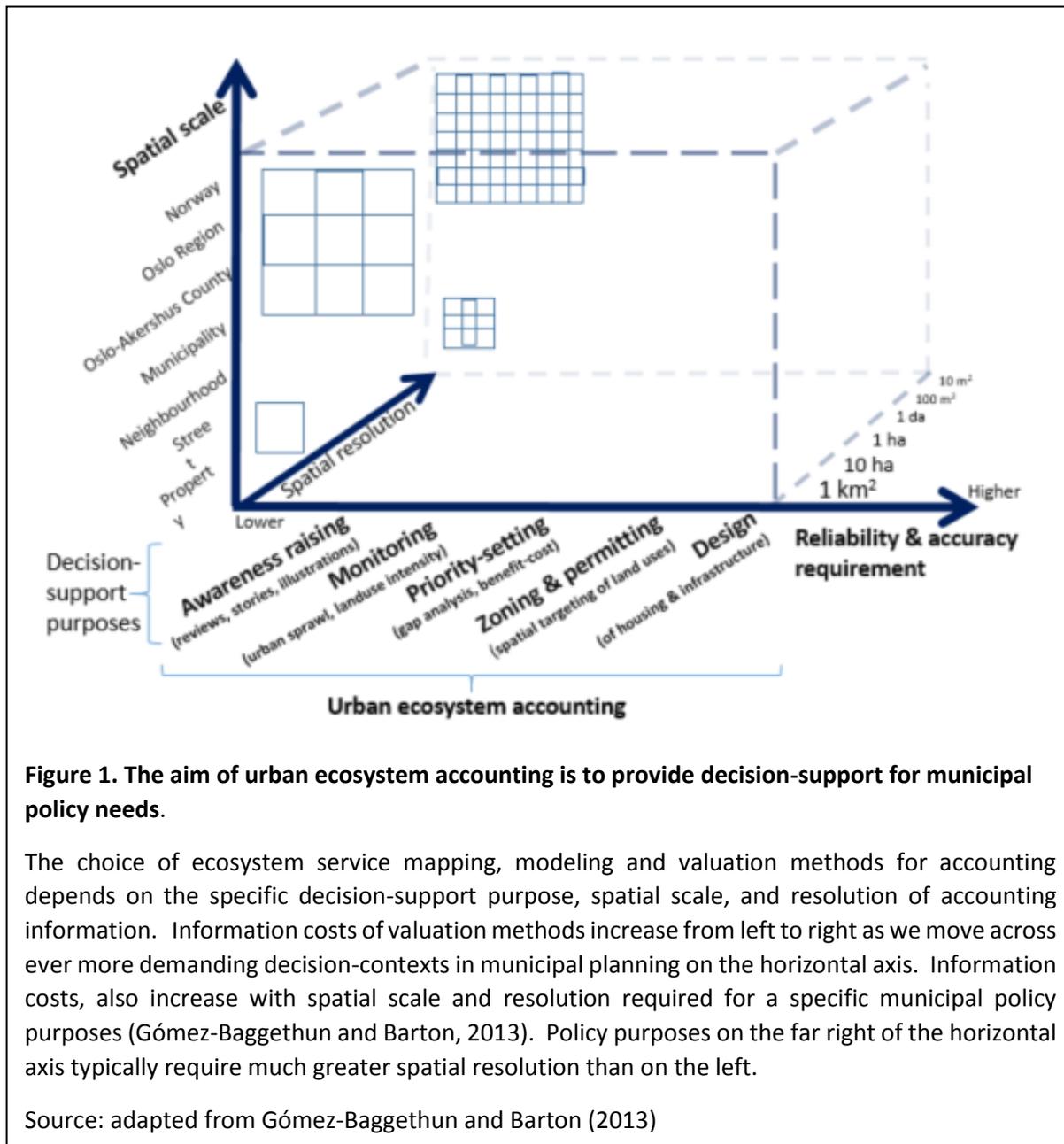


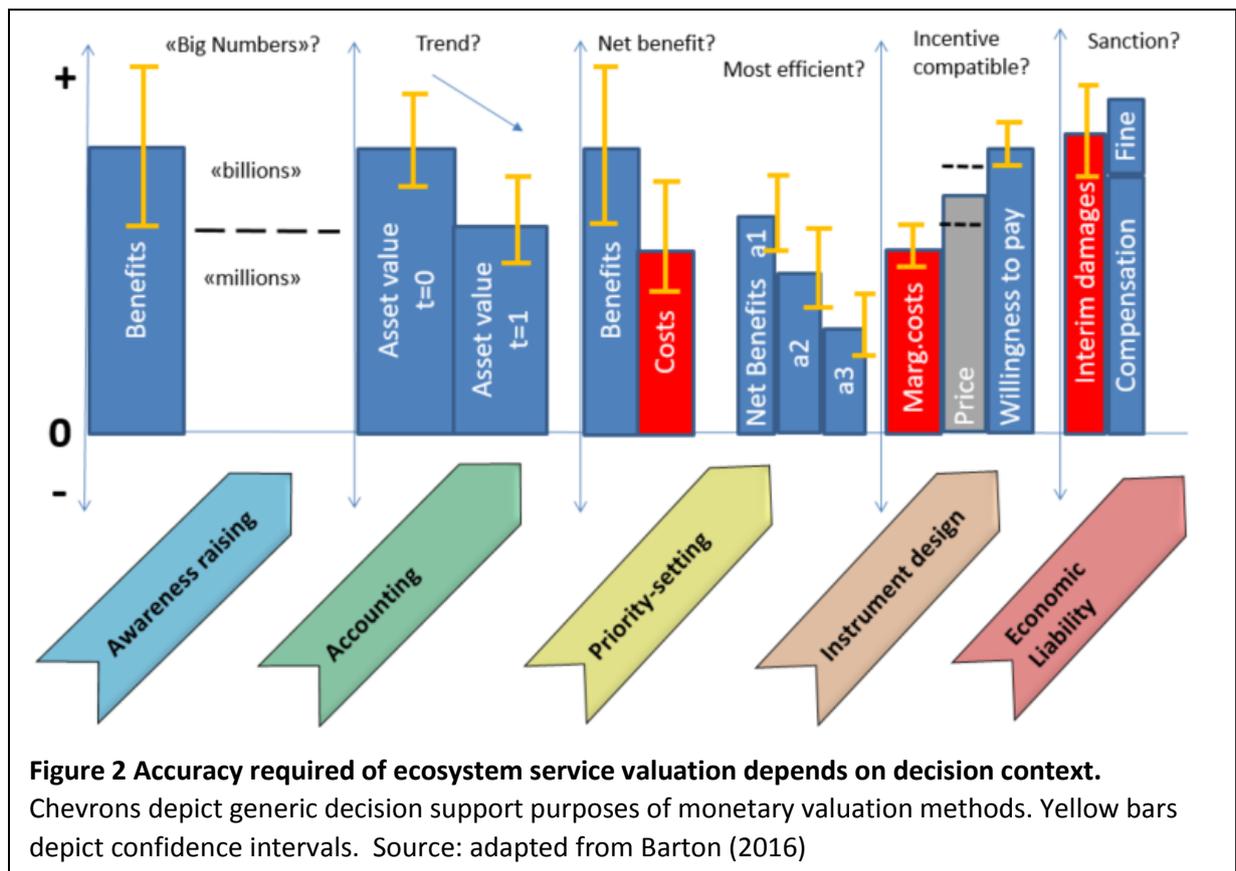
Figure 1. The aim of urban ecosystem accounting is to provide decision-support for municipal policy needs.

The choice of ecosystem service mapping, modeling and valuation methods for accounting depends on the specific decision-support purpose, spatial scale, and resolution of accounting information. Information costs of valuation methods increase from left to right as we move across ever more demanding decision-contexts in municipal planning on the horizontal axis. Information costs, also increase with spatial scale and resolution required for a specific municipal policy purposes (Gómez-Baggethun and Barton, 2013). Policy purposes on the far right of the horizontal axis typically require much greater spatial resolution than on the left.

Source: adapted from Gómez-Baggethun and Barton (2013)

1.3 Accuracy requirements for financial and economic decision support

The kinds of accuracy that may be expected of monetary valuation methods can be further illustrated for some broad types of financial and economic decisions (Barton, 2016). Figure 2 provides some examples of generic purposes of economic valuation discussed by Gómez-Baggethun and Barton (2013). A number of the municipal policy support purposes shown in Figure 1 also have an economic rationale which is reflected in the generic categories of Figure 2.



In the following we briefly explain Figure 2. Monetary valuation for *awareness raising* is the least demanding policy support purpose. There is an expectation that a method can distinguish between orders of magnitude in monetary values. In our experience, valuation that only shows “millions” for ecosystem services at aggregate municipal level do not have ‘a big numbers effect’. What constitutes an ‘awareness-raising number’ depends on expectations and points of comparison. Millions are “big numbers” relative to site specific studies, while “billions” operate at the same magnitude as for example municipal budgets. The purpose of *accounting* is monitoring changes in the monetary value of assets. Monetary valuation needs to have sufficient accuracy to identify significant trends between accounting periods in the value of assets. In priority-setting there are several distinctions to be made. A familiar distinction in benefit-cost analysis is between screening –taking action based on confidence about benefits being greater than costs –and ranking— identifying with confidence the decision alternative with the highest net benefits. Ranking requires greater accuracy than screening. In assessing feasibility of economic instruments such as water pricing or payments for ecosystem services, we expect valuation methods to be sufficiently accurate to set prices that cover full economic costs. If the purpose is to assess incentive compatibility, valuation of ecosystem services must be able

to determine whether benefits are higher than opportunity costs, but lower than willingness-to-pay (with some level of confidence). This purpose is at least as, or more, demanding than ranking for benefit cost analysis. Finally, in a legal setting economic liability for interim damages (before ecosystem services recover) would seem to place the highest standards on the accuracy of monetary valuation. We assume here that reliability and accuracy of monetary valuation results must stand up to a high level of scrutiny in court by a jury. The extent to which punitive fines —negative incentives— are considered, complicates this picture.

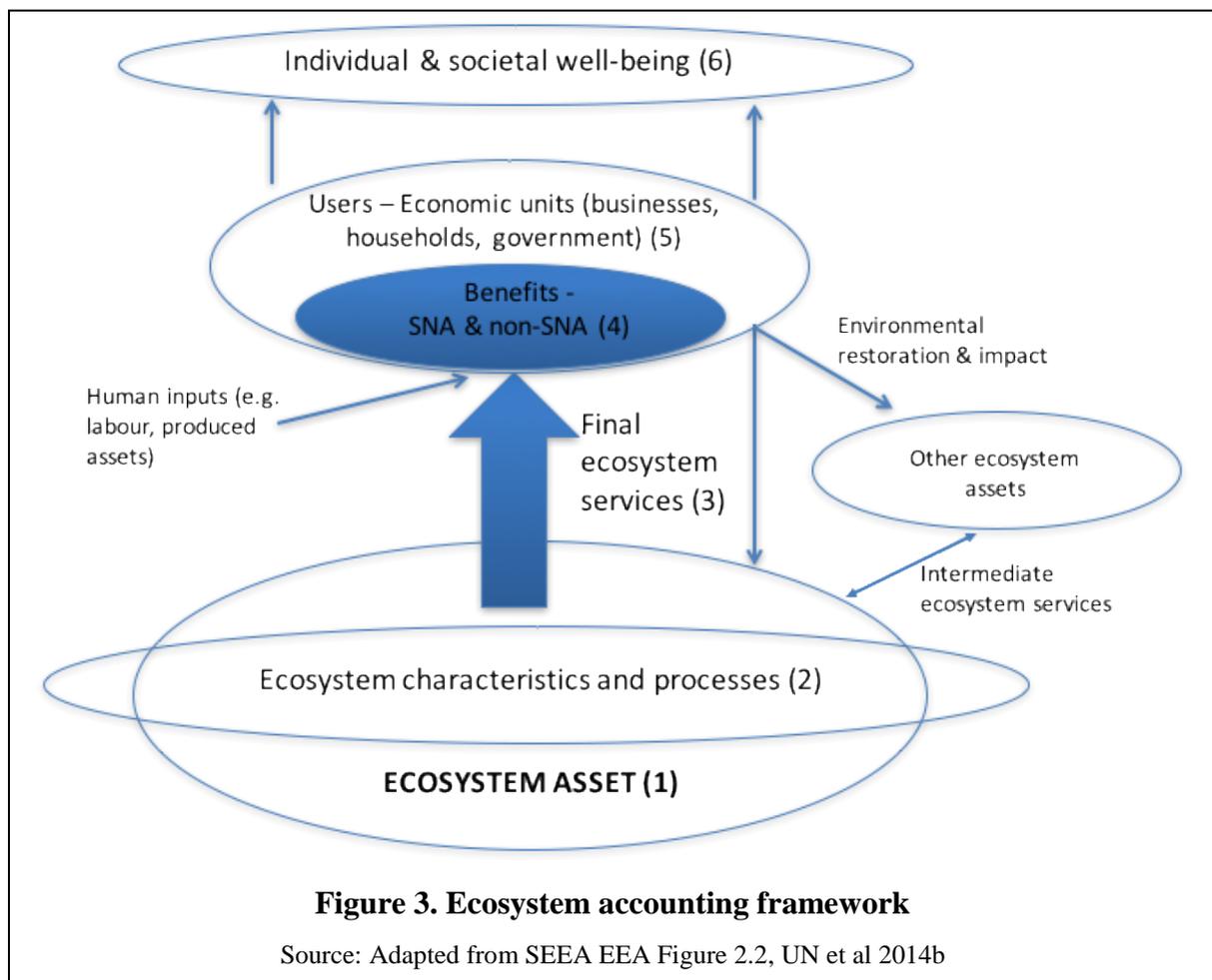
From the introduction on the purposes of SEEA EEA TR we see that ecosystem accounting is meant to have not only a ‘traditional’ accounting role in terms of monitoring trends in the value of assets (second chevron in Figure 2). It is also meant to be awareness-raising “*highlighting the ecosystem assets, ecosystem types and ecosystem services of particular concern for policy makers*”. It is expected to compare “*alternative uses of ecosystem assets*” which invokes either a screening (net benefits >0 ?) or a ranking (most efficient?) of landuse alternatives. Notably, these three stated purposes of the SEEA EEA TR for monetary ecosystem accounting have very different requirements for the accuracy of valuation methods, as illustrated by Figure 2.

A further purpose of ecosystem accounts is “*monitoring the effectiveness of various policies*”. The definition of effectiveness depends on the purpose of the policy. Figure 2 above, suggests that the effectiveness of policies such as an instrument might be evaluated in terms of incentive compatibility. Or the effectiveness of a fine might be evaluated in terms of whether it is effective as a sanction. These interpretations of effectiveness would require the highest levels of accuracy of the economic purposes illustrated in Figure 2. While not complete, the framework above can help question what economic decision support purposes we expect of accounting information. It may help us to question how much accounting information is enough for a given purpose.

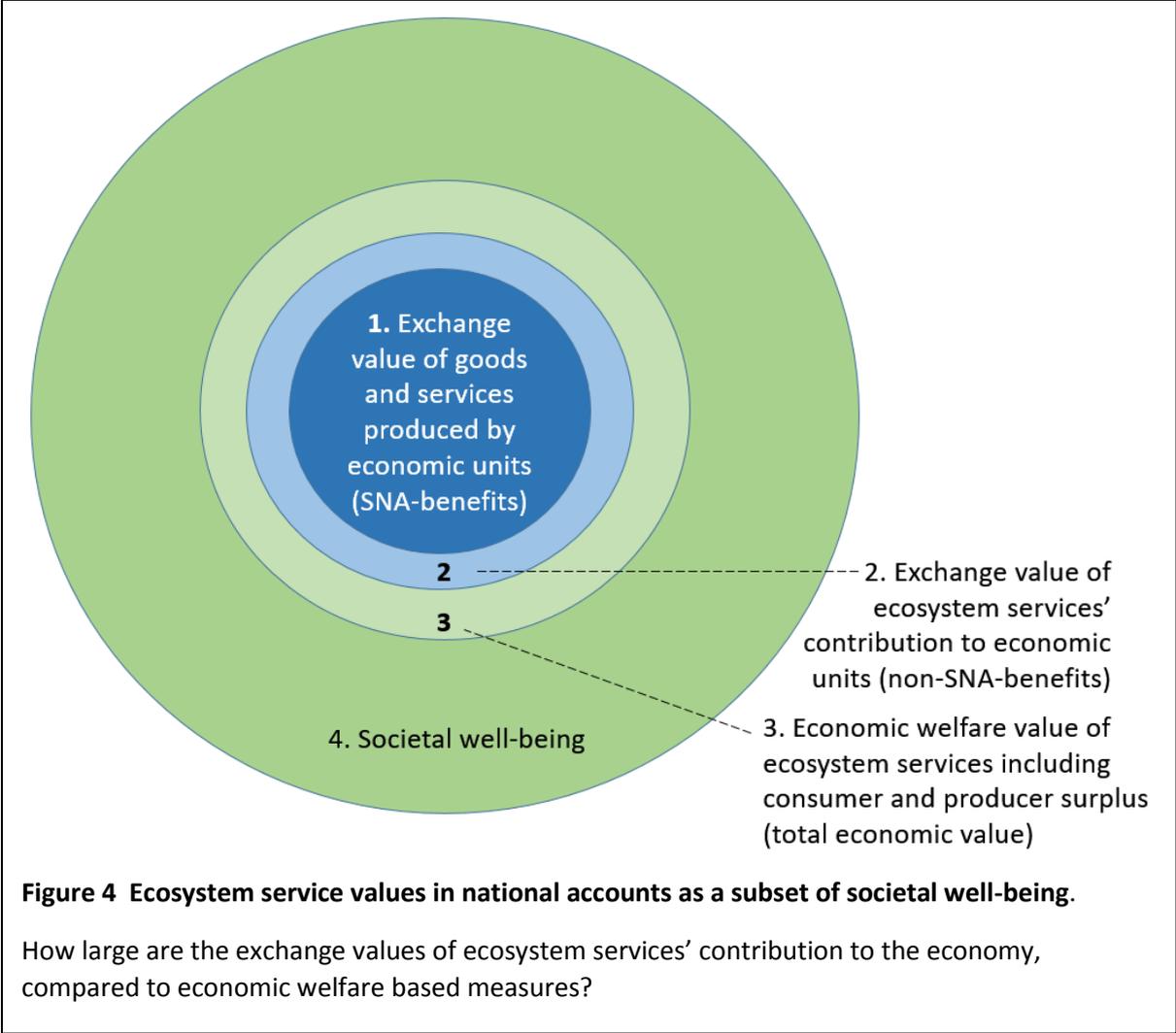
1.4 The significance of exchange value

Figure 2 also raises the question of the decision-support significance of the values identified using methods that meet SNA-compatibility criteria. Are the values large enough to make a difference in changing decisions in each of the purposes identified for SEEA EEA?

The SEEA EEA ecosystem accounting framework (Figure 3) shows an information flow from ecosystem assets through ecosystem characteristics and processes to “Benefits – SNA & non-SNA”. Figure 3 illustrates these benefits as a subset of “Users – Economic units (businesses, households, government)”, suggesting that the exchange value of SNA and non-SNA benefits represents a subset of use values. Finally, there is a flow of information to “Individual & societal well-being”. The SEEA EEA framework figure suggests that an overall purpose of ecosystem accounting is the contribution of accounting information to well-being. The valuation of SNA & non-SNA benefits has the most direct contribution, while indicators of ecosystem characteristics indicate well-being through physical ecosystem service indicators and accounting methods.



The ecosystem accounting framework suggests a hierarchy of values (Figure 4). Accounting compatible benefits – be they within the SNA production boundary or not - is a subset of societal well-being. Exchange values of ecosystem services are a subset of economic welfare from ecosystem services that includes consumer and producer surplus. In figure 4 we refer to the sum of these as total economic value.



The expectation implicit in the ecosystem accounting framework is that the exchange value of ecosystem services' - ring 2 in Figure 4 - represents a significant contribution towards total societal well-being.

We have deliberately drawn Figure 4 to illustrate the hypothesis that exchange values of ecosystem services (non-SNA benefits) following SEEA EEA TR recommendations, are small relative to the exchange value of goods and services produced by economic units (SNA-benefits). Furthermore the figure suggests the hypothesis that exchange values of ecosystem services are also small relative to valuation estimates using methods that capture consumer and producer surplus (3 in Figure 4). This has been suggested by Remme *et al.* (2015). Finally, it is recognised that economic values indicate a small subset of societal well-being (Hein *et al.*, 2015; IPBES, 2015).

While, the hypotheses illustrated in Figure 4 may be contrived, they are not trivial. The current SEEA EEA TR audience is national accountants, but SEEA EEA guidelines are already being scrutinized by welfare economists and social scientists more generally. Initial reactions to the requirements for accounting compatible valuation methods may fail to keep in mind that SEEA EEA TR is not claiming that the resulting exchange values represent all, or even most of societal values relevant for making policy decisions. This point has perhaps not been sufficiently communicated.

1.5 Valuation methods appropriate for ecosystem accounting

What are the criteria in ecosystem accounting for choosing monetary valuation methods that are compatible with the SNA? In the discussion on valuation methods (Chapter 7) three compatibility criteria can be discerned from the discussion:

1. **Stay within the production boundary.** Some cost and benefit flows fall outside the current SNA production boundary, as well as the proposed extension to ecosystems of the SEEA EEA TR. Notably of interest for estimating values of local nature recreation, the valuation of household time as an input to production is valued, but not as an input to non-remunerated activities such as recreation.
2. **Use exchange values.** This is the value of the service at the point of interaction between the supplier (the ecosystem asset) and the user. Exchange values reflect ecosystems contribution to the economy. Valuation methods that capture exchange value should be chosen.
3. **Avoid double counting.** Valuation methods should be able to identify separable service streams in order to estimate the the present value of the future flow of income attributable to an asset.

Literature testing monetary valuation of ecosystem services for accounting (Hein *et al.*, 2015; Remme *et al.*, 2015; Sumarga *et al.*, 2015) also discusses a fourth criteria, which is implicit to the awareness raising objectives of SEEA EEA TR discussed in the introduction. Ecosystem services are expected to have **significant or non-zero accounting values**. The empirical studies observe that resource rent methods often find zero or low rents for ecosystem contributions to open access uses, heavily subsidies resource extraction and public utilities operating according to cost-recovery principles.

2. Examples – assessing the accounting compatibility of ecosystem service valuation methods in Oslo

In the following valuation examples from Oslo, mainly drawn from the OpenNESS project², we discuss accounting compatibility criteria. Are the valuation estimates for urban ecosystem services appropriate or inappropriate from an ecosystem accounting point of view, as defined by the SEEA EEA TR? We also discuss the policy relevance of accounting inappropriate valuation methods that were carried out and compare that to the policy relevance of accounting appropriate values.

2.1 Hedonic pricing

Hedonic pricing decomposes the value of an asset into its attributes and prices each attribute using regression analysis. In the housing market large samples are needed, using historical sales data from across a housing market, often from a decade or more, including property structural characteristics. GIS modelling determines proximity to ecosystem assets and their condition. Spatial econometric

² <http://www.nina.no/english/Research/Projects/OpenNESS>

methods are used to identify the effect of ecosystem assets on property price, while controlling for other structural and neighbourhood characteristics. The method has been used to value access to green space, air quality and noise. SEEA-EEA Tech 2016 deems the method appropriate in principle if individual ecosystem services can be identified.

Hedonic property pricing has been tested in Oslo to account for the total contribution of public green and blue areas (Figure 4) – including managed parks, unmanaged nature areas, cementaries, water features, per-urban forest and coastline - to the capital values of city apartments (Vågnes Traaholt, 2014; Barton *et al.*, 2015). Considering model error and variation in the apartment characteristics a lower bound estimate for public green-blue areas in the city was at least 19 billion NOK in capital value added to apartments in Oslo. This total estimate is based on identification of separate effects for different types of urban green space (Figure 4). For example, living within 500 meters of parks contributes 8,3-18,9 billion NOK to the capital value of apartments. There is an additional property price effect of living close to large parks (>100da) of 0,3-2,3 billion NOK. And there is an effect of proximity to parks with water features capitalized at an additional 2,8-6,6 billion NOK in the sales value of apartments.

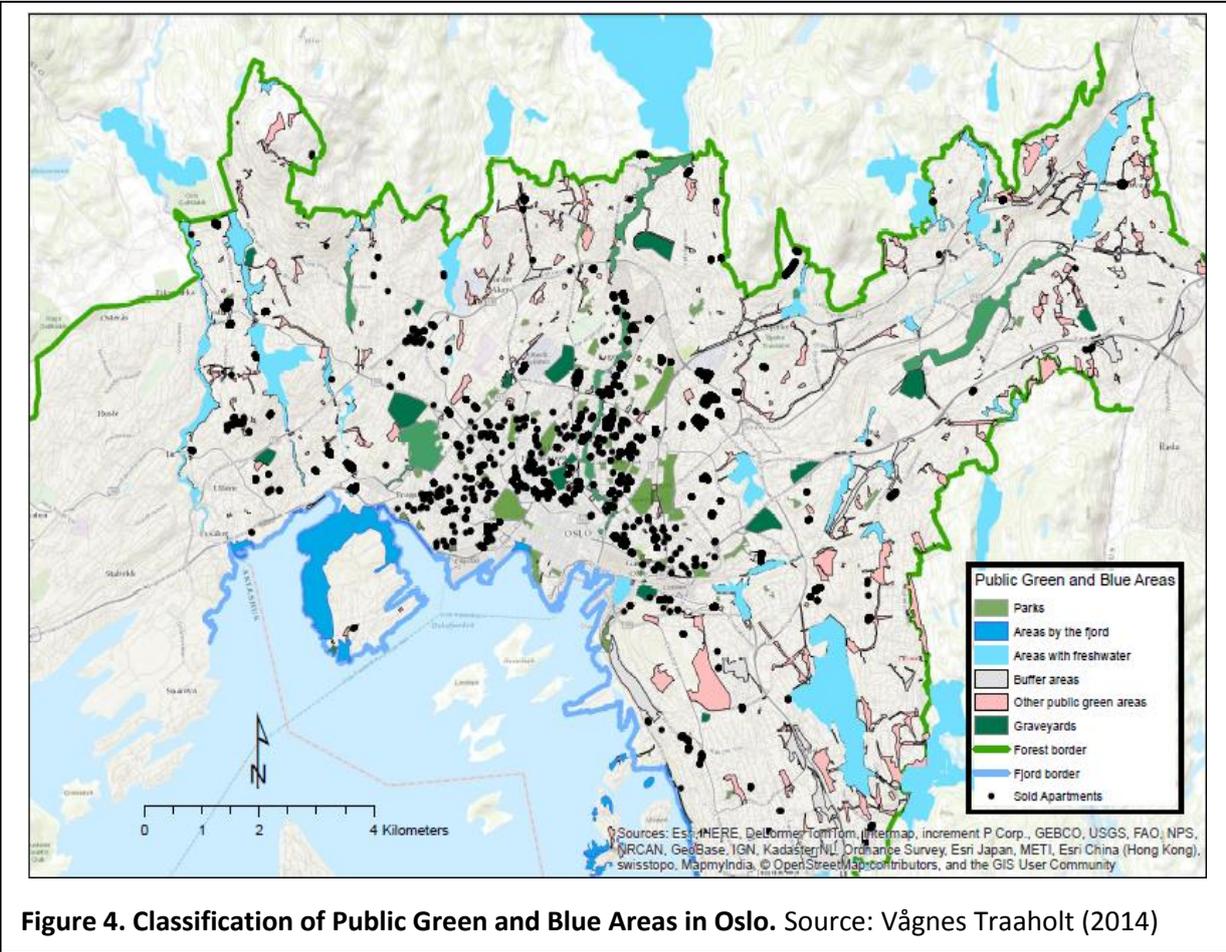


Figure 4. Classification of Public Green and Blue Areas in Oslo. Source: Vågnes Traaholt (2014)

Hedonic property pricing is methodologically attractive for ecosystem accounting because it provides capital values directly, assuming that buyers and sellers have considered the expected and experienced streams of benefits from the property, and discounted them using mortgage rates. However, the method struggles to fulfil the SEEA-EEA criteria of 'separate identification of individual ecosystem services'. Hedonic pricing studies identify bundles of ecosystem services under the heading

'amenities' (Czembrowski and Kronenberg, 2016). Even if agents in the housing market were able to sum expected benefits from different uses of green spaces, there is an identification problem. Identifying the separate effects of different types of green areas is already challenging due to spatial autocollinearity issues. Estimation problems may become intractable when green spaces are a further classified / disaggregated according to individual ecosystem services. Some headway can be made by identifying attributes of green spaces that are functional types, i.e. associated with specific uses. An example was given in the Oslo case, where large parks with water features attributed more capital value to apartments in their proximity, than t parks without these characteristics. Large parks with water are associated with a greater diversity of recreational activities in Oslo (Soy Massoni *et al.*, in press).

Follow-up hedonic pricing studies conducted within the URBAN EEA project (Heyman *et al.*, 2017) have shown that hedonic amenity values from ecosystems are highly sensitive to model specification. In particular, specification of green space variables in terms of proximity or percentage coverage; modelling of linear versus network walking distance proximity; and inclusion of variables representing cultural and commercial services associated with green spaces, can have significant effects on estimates of urban ecosystems contribution to property prices. Testing of robust model specifications is on-going.

2.2 Marginal values from demand functions

Marginal values from demand functions are estimated by utilising an appropriate demand function and setting the price at a point on that function intersecting with (i) observed behaviour to reflect supply (e.g. visits to parks) or (ii) modelling a supply function. The method can use demand functions estimated by travel cost or stated preference methods. These are methods that are otherwise considered inappropriate for direct valuation as they use the demand function to estimate consumer surplus. We note that the SEEA-EEA Tech 2016 considers these methods potentially technically challenging – they involve computing both a demand function and a supply function and inferring a hypothetical exchange value. The demand function of the travel cost method may be estimated using different rates of visitation as a function of travel expenses.

We should note that in the SEEA EEA TR, the opportunity cost of the travel time used by the household is considered outside the scope of the production boundary used for accounting purposes. Furthermore, we note that *'by convention, the measurement scope of non-SNA benefits for ecosystem accounting purposes is limited to the flow of ecosystem services with a direct link to human well-being'* (SEEA-EEA Tech 2016). We also note that *'the SNA production boundary currently includes goods and services produced through illegal activity and subsistence production, i.e. these products form a part of the set of SNA benefits.'*

Below, we discuss the valuation of household recreation time in green space in and around Oslo and question the accounting boundary of ecosystem accounts.

Representative household surveys of the number of visits during a year to different public green spaces are relatively low cost and repeatable. In Oslo we have fielded a household survey³ (Figure 5) assessing visitation frequency across a landscape gradient from city streets in Oslo to old growth forests in its peri-urban forest called Marka (Figure 6). Visitation rates are then combined with estimates of visit time for the different green space type to calculate total visit time per year to urban ecosystems in the metropolitan area. For example, Barton et al. (2015) estimated a total 71 million visitation hours/year to the whole of the peri-urban Marka forest.

The question we are concerned with here is whether this recreation service can be included in use accounts and how marginal exchange values could be estimated from this demand function (Figure 4).

There seem to be several challenges: (1) policy relevance; (2) measurement; (3) conceptualising recreation time as an ecosystem service (4) household time costs falling outside the SNA production boundary, and (5) the choice of monetary valuation method for time.

Addressing the problems in turn:

Relevance (1): We argue that time spent in green spaces constitutes a policy relevant measure of the physical demand for recreation. It is a significant indicator of value of cultural ecosystem services. Time spent in ecosystems for recreation depends on the extent and condition of recreation areas, and thereby fulfills the non-monetary accounting purpose of monitoring physical changes.

Measurement (2): number of visits by season, time spent traveling to, and time spent onsite within an ecosystem are all becoming more easy to observe on a regular basis through online surveys, and GSM and GPS tracking. Considering the size of the service in relation to the relatively low costs of obtaining recreation data, there are strong practical reasons to account for recreation time, either in use accounts or in parallel thematic accounts.

Conceptualising recreation time as an ecosystem service (3): recall that SEEA EEA implies an extension to the standard production boundary to include goods and services from ecosystems to the economy. Conceptually, ecosystems provide supporting services in terms of habitat for biodiversity, but also for

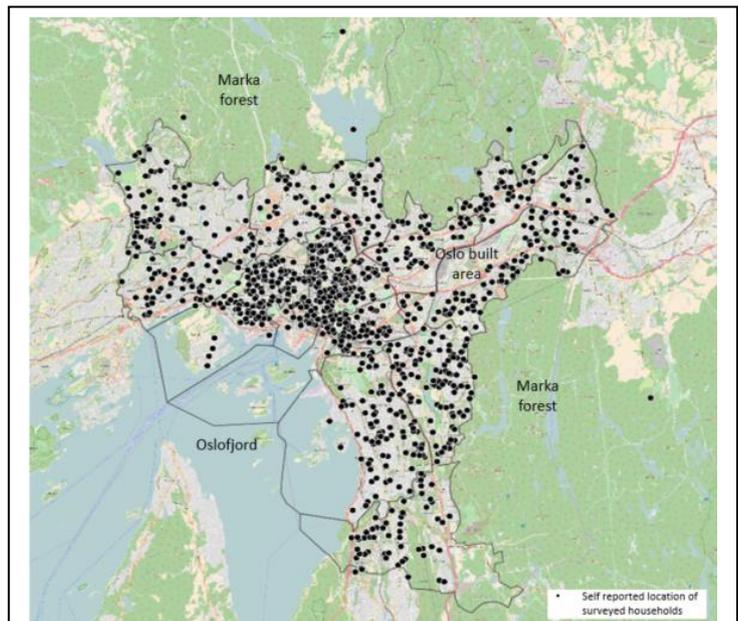


Figure 5. Household locations in Oslo recreation survey (2016)

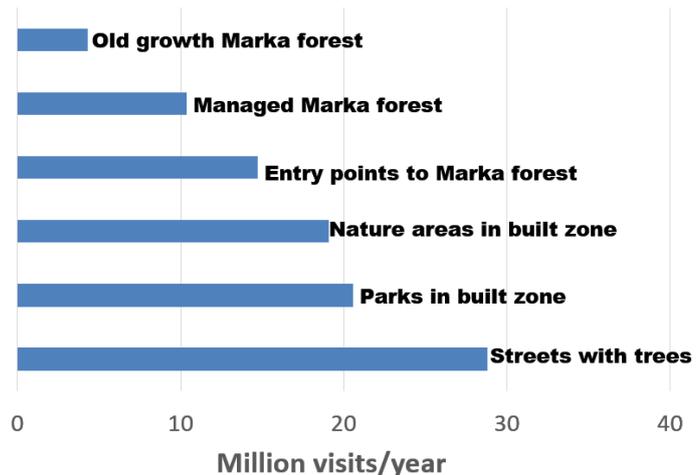


Figure 6. Recreation demand across Oslo's green spaces (2016)

³ 2016 Survey conducted by the URBAN SIS project, Norwegian Institute for Nature Research(NINA)

humans. The habitat service provided is “time in the habitat”, as the word ‘inhabitant’ suggests. Time in a habitat can therefore be thought of as a final ecosystem service. Time traveling to an ecosystem can be conceptualised as an input. However, by excluding households time spent in nature accounting standards exclude what we could call ‘human habitat services’ from the production boundary.

Production boundary (4): Household time use is considered within the production boundary as labour input to production of goods and services, whether marketed or subsistence. For example, the production from berry and mushroom picking is considered within the production boundary. Household production of services for own final use is outside the production boundary of SNA (with the exception of paid domestic service and owner-occupied dwelling services)(OECD, 2002). The recreational value from nature for local resident households is considered a non-SNA benefit (Remme *et al.*, 2015).

Monetary valuation (5): Nature tourism has previously been valued by allocating a share of total national net revenue in the tourist sector, assuming average expenditure and travel times differentiated by region (Remme *et al.*, 2015). This approach cannot be used to indicate the economic contribution of local nature to local residents’ recreation. Travel and accommodation expenses in local recreation are very low relative to total visitation time in local nature.

Remme *et al.* (2016) suggest estimating an exchange value through the intersection of a modelled demand and supply curve, called simulated exchange value approach (Oviedo *et al.*, 2010). Alternatively, they propose observing actual visitation rates to recreation areas. They do not provide any further guidance on how to carry out the valuation of those visits.

Barton *et al.* (2015) tested several different monetary valuation methods for visitation frequency and duration in the Marka forest around Oslo (Table 1). We discuss them here as they help us explore different concepts of marginal valuation of recreation from an SNA perspective. The study suggested that the **opportunity cost of time** - the foregone income after tax due to recreating instead of working – could be used to value time spent in the Marka forest. Valued at opportunity cost of time, annual recreation in the Marka forest was estimated to be worth around 13 billion NOK/year (Table 1). This approach meets the criteria of using the exchange value (wages). It avoids double counting transfers (net of taxes) and will avoid double counting of recreational amenities provided it is not used together with hedonic pricing (see above). There are also some weaknesses. The opportunity cost of time

Table 1 Monetary valuation of local recreation tested for Oslo Marka forest

Valuation methods	Per month	Per hour	Per trip	Total value of visits to Marka forest (NOK/yr.)	Assumptions and sources
Exchange-based' valuation of recreation time					
Opportunity cost of time; wage after tax (100%)		187		13 297 333 559	rate based visitor sample Svartdalen Park (August 2014)
Opportunity cost of time; wage after tax (33%)		62.27		4 428 012 075	assumptions in Sælen and Ericson(2013) & Svartdalen sample
Replacement cost - cost of training in a gym	453	37.75		2 684 354 769	assume 12 hours/month studio subscription use
Average trip expenses Oslo (whole year)			53.69	1 255 632 448	Sælen and Erikcson (2013) ; 50% car, 50% public transport
Willingness to travel (WTT) choice experiment					
WTT cost (spring-summer-autumn)			124.8	1 957 550 484	based on Sælen and Erikcson (2013)
WTT cost (winter)			209.3	1 612 318 420	based on Sælen and Erikcson (2013)
WTT cost (whole year)				3 569 868 904	based on Sælen and Erikcson (2013)
Consumer surplus (CS) = WTT - average trip expenses					
CS (spring-summer-autumn)			71.09	1 115 313 264	Sælen and Erikcson (2013) ; 50% car, 50% public transport
Choice experiment (winter)			155.64	1 198 923 192	Sælen and Erikcson (2013) ; 50% car, 50% offentlig transport
Choice experiment (whole year)				2 314 236 456	Sælen and Erikcson (2013) ; 50% bcar, 50% offentlig transport
Travel cost method (meta-analysis)			143.6	3 358 718 206	Zandersen and Tol(2009)

Source: based on Barton *et al.* 2015

assumption holds if higher wages lead to a substitution of recreation for more work⁴. Recreation time allocation may on the contrary not be very elastic. Furthermore, travel cost studies have questioned that the opportunity cost of time spent traveling is equal to foregone wages net of taxes. A common rule of thumb in travel cost studies has been to use a fraction of opportunity costs (Sælen and Ericson, 2013), although the adjustment factor used is often not based on empirical work. At a commonly used 33% of wage rates net of taxes, the recreation in Marka forest has an exchange value of 4,4 billion NOK/year. A more conceptual critique is that the opportunity cost of labour uses an estimate based on the impact on the economy of labour foregone to recreation, rather than the benefits of recreation itself. This critique forces us to consider that there are few direct economic impacts of local nature recreation.

Barton et al. (2015) also explored alternative exchange-based valuation methods. Assuming that forest recreation is for the sole purpose of physical exercise, a **replacement cost** of training in an indoor gym could be used as an exchange value. Assuming a moderate training regime of 3 hours per week with a reasonably priced monthly subscription at an indoor gym, the replacement cost of physical exercise in the Marka forest is valued at about 2,7 billion NOK/year. The method's weakness is that it does not represent a perfect substitute for forest recreation by not capturing any of the mental health benefits of outdoor recreation in nature⁵. To obtain more accurate estimates we would also need information about what part of our population of recreation users would substitute physical exercise in the forest for training in a gym, in the hypothetical situation that the Marka forest was unavailable⁶.

An alternative approach would be to assume that the exchange value of forest recreation in Oslo is equal to **travel expenses**, by car or public transport, excluding the opportunity costs of travel time. Using data from a survey by Sælen and Ericson (2013) and assuming equal private-public travel shares, we estimated the recreational value of the Marka forest to be 1,2 billion NOK/year. Contrary to the travel cost method, this does not use travel times to estimate a demand curve. Sælen and Ericson (2013) demonstrate how a demand curve can be estimated using a choice experiment of willingness-to-travel⁷. In order to simulate a demand curve, an experiment must assess willingness-to-travel at different levels of accessibility or quality. The authors simulated willingness-to-travel to experience different conditions of bare ground, slush or snow, assuming that weather randomly affects the location of these condition within the Marka forest by season. Using their estimated demand curve and travel expense rates for public and private transport, Barton et al. (2015) estimated a **recreational surplus** of Marka forest recreation to be about 3,6 billion NOK/year. By itself this approach is conceptually similar to the travel cost method. We also estimated a consumer surplus net of average trip expenses at 2, 3 billion NOK/year. Finally, we used benefits transfer from a meta-analysis of **travel cost** studies to estimate a **transferred consumer surplus** of 3,4 billion NOK/year. These latter three examples all estimate a consumer surplus value, which is considered inappropriate for accounting purposes.

2.3 Contingent valuation

Contingent valuation is based on survey responses to willingness to pay questions for ecosystem services, and used to estimate economic value for awareness raising purposes, or as input to benefit-cost analysis. The SEEA-EEA TR suggests that using values directly from the method is inappropriate

⁴ This could be tested by looking at the correlation between income and recreation time.

⁵ Notice the tendency of health studios and gyms to place apparatus behind large windows facing streets when views of trees or green space are available.

⁶ Notice that a hypothetical counterfactual scenario needs to be defined in order to use the replacement cost method accurately. Hypothetical values is one of the principle critiques of the contingent valuation method.

⁷ Similar in concept to contingent valuation of willingness to travel.

since it measures consumer surplus, rather than exchange values. However, as discussed above for simulated exchange values, the SEEA EEA TR suggest it is possible to estimate a demand curve from stated preference studies. This information may be used in forming exchange values for ecosystem services.

As an example, the contingent valuation method was used in Oslo to obtain the willingness to pay a municipal fee for maintaining the density of public street trees. Aggregate willingness to pay across Oslo's population was estimated at 60 million NOK/year for maintaining or increasing street trees across the city (Haavardsholm, 2015). By comparison, current municipal costs for maintaining trees in municipal parks and streets only is 12 million NOK/year.

While these contingent valuation estimates cannot be used directly to estimate the value of current street trees, the information is useful as decision support and for determining a financially feasible level of supply. Municipal utility services such as water and waste management are charged according to the cost recovery principle (i.e. no producer surplus). Contingent valuation estimates could be used to determine is enough households would pay a cost-recovery fee to make it financially feasible. Also, contingent valuation estimates could be used to determine the increased level of street tree maintenance possible if the stated amount was actually charged to households, following a cost-recovery principle. Future increased supply – here increased maintenance of city trees - might be based on the findings from this contingent valuation study, thereby determining future maintenance costs and the cost recovery fees per household.

While not determined by a market transaction, a public utility fee for maintenance costs of street trees can be seen as accounting appropriate as it is a service transaction price (although, similar to nature, public utilities are often rights, or technically difficult to withhold even if no payment is forthcoming from the user). Providing the utility of public street trees at cost-recovery levels mean that street trees have no residual resource rent. However, even at cost-recovery levels street trees may provide consumer surplus to beneficiaries. This value would be ignored by accounting standards.

2.4 Restoration cost

Restoration cost refers to the estimated cost to restore an ecosystem asset to an earlier, benchmark condition. The SEEA-EEA Technical recommendations suggest that the methods is likely to be inappropriate since it does not determine a price for an individual ecosystem service, but may serve to inform valuation of a basket of services. Accounting incompatibility in this case is due to an increased risk of double counting when ecosystem services cannot be identified separately, and instead are valued as a bundle associated with a specific ecosystem site or green structure. The valuation method is nevertheless useful in municipal policy, and can meet accounting requirements under special conditions.

For example, in the city of Oslo, restoration costs of city trees is calculated as a basis for a compensation fee to be paid by parties responsible for damaging trees on public land (Barton *et al.*, 2015). The price of nursery trees is adjusted for the age, health and contribution of the tree to site-specific qualities. Expert judgements of a city arborist are used to score these qualities and arrive at an adjusted restoration cost. This restoration cost is often taken as a transaction cost by property developers when destroying a tree as part of construction is unavoidable. As such this is an exchange value, although the 'transaction price' has been set through regulation rather than the market. Regarding the risk of double counting, this may be avoided by not including municipal trees in other valuation models (e.g. hedonic pricing models as discussed above).

3. Discussion

In the following we discuss some possible implications of the Oslo valuation examples for recommendations regarding accounting compatible valuation methods.

3.1 On hedonic pricing, amenity values and double counting

The objective of monetary accounts in SEEA EEA is to extend traditional accounting to capture ecosystems contribution to the economy. Does it fulfill this objective by excluding information from a market that arguably provides more information on the exchange value of land characteristics than any other? The accounting compatibility criteria of identifying individual ecosystem services is a means to avoid double counting of services. But the classification of ecosystem services is an accounting convenience that may have greater or lesser resolution depending on the purpose of accounting and the ability of methods to identify non-overlapping types in relation to benefit streams. Benefits from ecosystems can be subclassified by increasingly more detailed segments, according to type of beneficiary, time and place the benefit occurs - the definition of "individual ecosystem service" is therefore a flexible one.

Even though the functional dependence of different types of recreational benefits on different physical qualities of green space cannot be identified, and even though the recreational composition of each household is not observed, hedonic property pricing still makes it possible to observe aggregate effects of green spaces on property values.

Table 2 summarises why identification of individual ecosystem services is arbitrary for the purposes of hedonic pricing. Amenity service value is by our own definition in Table 2 a 'single ecosystem service', but it does not necessarily avoid double counting with methods that identify individual recreation values. We can conclude that avoiding double counting is not a matter of strictly choosing only those methods that value single ecosystem services, but of which non-overlapping valuation methods to combine given the way ecosystem services have been classified.

Table 2 Example of an arbitrary but practical definition of ecosystem services for the purposes of hedonic valuation of amenity services from urban ecosystems

Exchange value	Use value	Benefits	Amenity services	Physical qualities of blue and green spaces
amenity service value as a bundle of potential uses conditional on bundles of green space characteristics	unidentified expected recreational uses specific to the property location, as priced by seller and purchaser	recreational uses of green space: walking jogging biking swimming [...]	unidentified functional links between potential recreational uses and physical characteristics of green spaces	Blue-green structures
				Air quality
				Water quality
				Noise, sound
				Odour
				Temperature
				Natural hazard (flooding, slides)

3.2 On the exchange values of urban recreation

Household production of recreation is a service that falls outside the SNA. However, we could argue that with the extension of the production boundary of SNA to ecosystems, recreation in those ecosystems should come within the boundary as well. The 1993 SNA recommends that (para. 6.25)

“the production of a good for own final use should be measured when the amount is believed to be quantitatively important in relation to the total supply of the good in the country.” Because recreation is a service it falls outside the production boundary, and outside ecosystem accounts. While recreation is a service, it is a quantitatively important activity for household subsistence in a wide sense. Time allocation to nature recreation is significant and comparable some households to salaried time use.

Barton et al. (2015) found consumer surplus-based estimates to be roughly similar to the replacement cost estimate (Table 1), although admittedly we have not carried out sensitivity analysis on each of the methods. The value based on opportunity cost of time was roughly four times higher than the recreational surplus estimate, using Sælen and Ericson’s data. Conversely, Remme et al. (2015) found consumer surplus values roughly 4 times higher than exchange values for air quality regulation services in Limburg. The difference in the 1:4 versus 4:1 ratio of exchange value to consumer surplus between cultural and regulating ecosystem services may be due to many factors. One difference that stands out is the use of pressure-state-impact-response model chains to assess regulating services – long cause-effect chains may attenuate the value of off-site air quality, when monetary values are anchored to on-site pollution mitigation costs.

Remme et al. (2015) suggest that simulated exchange value methods should be tested in future, citing Oviedo et al. (2010). Oviedo et al. (2010) estimated per visitor costs of fixed visitor infrastructure and variable management costs of an open access natural park in Spain. They assumed that current management costs per visitor would increase proportionally with each visit. They intersected the resulting park management supply curve with trip-expenditure willingness-to-pay, estimated from a contingent valuation survey.

Arguably, recreational forest supply has a lower marginal cost than management of formal protected areas. The simulated exchange value method would seem to work well in cases with significant marginal costs per visit (e.g. personal visitor services at the entrance to a National Park) (Figure 7.1). However, the more ‘flat’ the supply curve of ecosystem management, the closer one is to a situation of an unmanaged natural area (Figure 7.2). For recreation in peri-urban neighbourhood forests such as Marka around Oslo, the supply curve is almost flat and the marginal exchange value according to a simulated exchange value approach would be equal to average fixed costs per visit (which are almost zero). In many areas the simulated exchange value would be near zero.

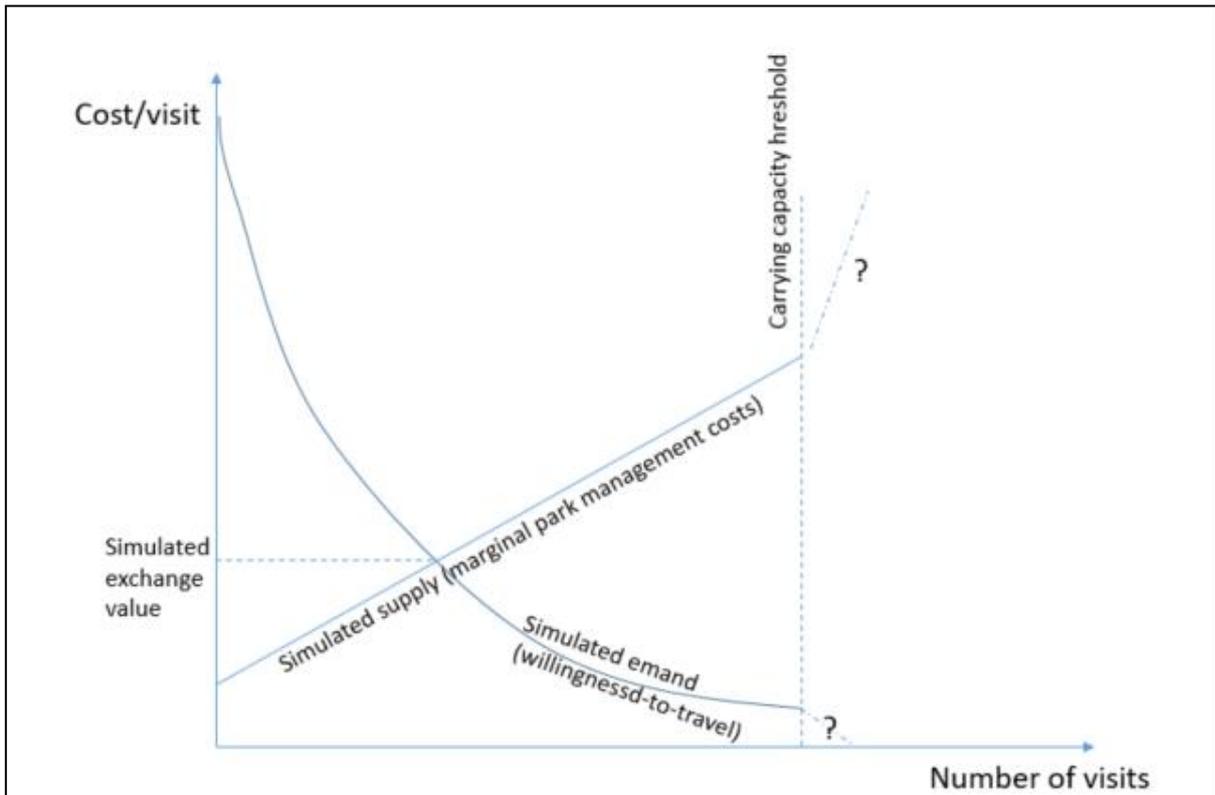


Figure 7.1 Simulated exchange value of recreation to a park with variable costs of visitation

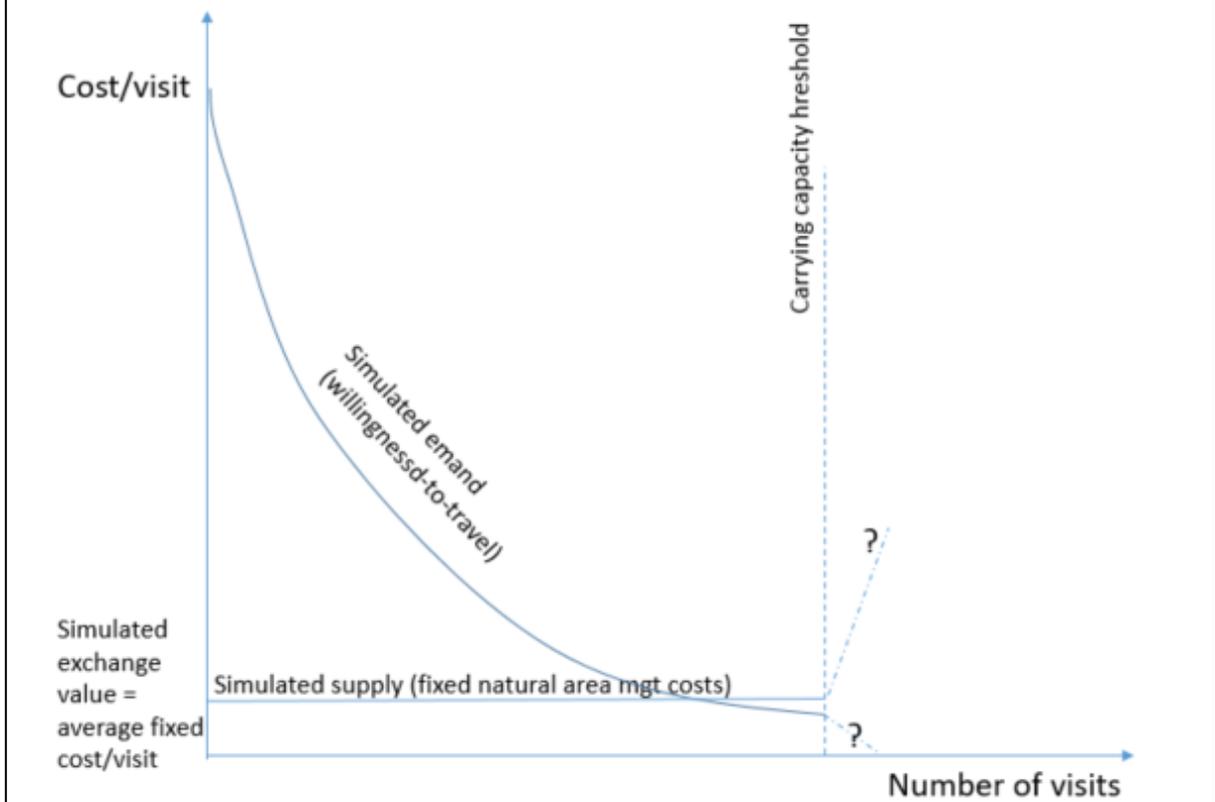


Figure 7.2 Simulated exchange value of recreation to a natural area with low fixed costs and no variable costs of visitation

An 'accounting appropriate' simulated exchange method for public open access low-management green spaces suffers from similar challenges to the 'zero residual rent' problem seen for public utilities. It is intuitively clear that the recreational service of the peri-urban forest has large total public benefits. The peri-urban ecosystems support a large user population, but the marginal exchange value is low. This should open up a space for reinterpretation of the production boundary with regards to value of household time, and/or other methods than those currently cited in the SEEA EEA TR.

Another conceptual critique concerns the intention to value the benefits of an ecosystem service as directly as possible. Time spent in recreation areas is a service with mental and physical health benefits. The value of these benefit to the economy could be estimated in terms of preventive expenditure, avoided health costs, or expected income of quality adjusted life years. This would require considerable additional epidemiological information and additional assumptions. Although it has some conceptual flaws, the opportunity cost of time would seem a more straightforward marginal exchange value, which can be based on national statistics, with no epidemiological assumptions.

3.3 On the relevance of monetary ecosystem accounting for municipal decision-making

Several themes have run through the discussion of the valuation examples from Oslo. How reliable and accurate are the valuation methods? Are the values observed significant – i.e. “big numbers” - in the municipal policy context? Do accounting standards exclude reliable and significant valuation estimates? Are valuation estimates that are inappropriate for accounting still useful for municipal policy making?

We have discussed several examples:

- The willingness-to-pay for maintenance of street trees as a public utility using contingent valuation is inappropriate for accounting. However, the demand curve information could be useful for the city in setting financially feasible maintenance levels for the future.
- Quality-adjusted restoration costs of street trees is not appropriate for accounting because it values a bundle of ecosystem services. However, the restoration cost method has already been adopted by the municipality as a damage assessment method used to set fines. When used for accounting it also reveals “big numbers”, which have been used for awareness raising by the municipality⁸.
- Hedonic pricing is appropriate for accounting, reveals “big numbers” as aggregates for the city. But the method is not accurate in terms of predicting the values of non-marginal changes in the supply of green spaces in particular neighbourhoods. While research is ongoing, ecosystem asset values derived from hedonic pricing are currently not robust to different model specifications.
- Simple valuation methods such as opportunity cost of time in nature recreation are reliable, but possibly inappropriate with regards to the production boundaries in SNA. Alternative valuation methods that have been proposed for valuing urban nature recreation are expected to also have weaknesses such as deriving theoretically correct, but low or zero exchange values. Nevertheless, we observe tens of millions of hours of recreation in urban parks and forests every year.

⁸ http://www.openness-project.eu/sites/default/files/osloopenness_insight.pdf

A tentative conclusion from our case examples is that ecosystem accounting criteria for monetary valuation excludes information that is policy relevant. Accounting compatible methods – such as hedonic pricing – may require a large number of assumptions, making values sensitive to specification error and/or inappropriate for impact assessments at local level. However, despite low accuracy and context sensitivity, they may be useful at aggregate scales, at low spatial resolutions and for awareness raising purposes. Information from stated preference methods may be used to estimate accounting compatible values, but economic values measured by consumer surplus may be relevant for awareness raising or priority-setting using benefit-cost analysis.

Valuation of local nature recreation using consumer surplus based methods does not capture health effects, nor the cultural significance of green spaces. Physical accounting data – such as visitation rates - provides decision-relevant information, especially when monetary valuation methods are lacking.

The importance of monetary accounting information lies in being able to ascribe whether the change in relative value is due to a change in extent or in exchange value per unit. How much does accurate measurement of an absolute (rather than relative) magnitude of exchange values matter for policy? If exchange based values are a subset of welfare economic values, which are a subset of societal welfare, then exchange values alone cannot be used to prioritise policy or project decisions at municipal level. In that case, the magnitude of exchange values is less important than monitoring the change in value of ecosystem assets over time, as long as the valuation methods chosen are applied consistently over time.

4. Conclusions

SEEA-EEA technical recommendations are being tested at the municipal level within the metropolitan area of greater Oslo, Norway, but the URBAN EEA project⁹. We are testing how the SEEA-EEA framework can identify the economic contributions that urban ecosystems make to the municipal, household and commercial sectors in greater Oslo.

Local and city governments already make use of landuse mapping and thematic environmental and socio-cultural indicators to inform impact assessments, municipal planning and zoning. Ecosystem accounting offers a complementary set of indicators to municipal government in Oslo to make fragmented urban nature and blue-green infrastructure more visible in city planning. Characteristics of cities in general limit the scope of monetary ecosystem accounts in the assessment of municipal policy targets:

- For example, urban green structures can be small and hard to identify in GIS (but have a high per unit area value). Remnant and constructed urban nature is highly spatially fragmented.
- Mixed-use density of green spaces is high and highly localised. This makes it challenging to identify marginal values of particular green space qualities and ecosystem services from transactions in the property market.
- Municipal utilities such as water supply, rainwater management, sewage treatment and solid waste management operate according to cost-recovery. This means that the residual resource rent attributable to ecosystems is low or zero.
- Recreational time use in neighbourhood public spaces is very high relative to travel expenses to use the areas, leaving little trace in market transactions.

⁹ Urban Experimental Ecosystem Accounting.

Given these and other challenges of valuing urban ecosystem services (Gomez-Baggethun and Barton 2013)(Jacobs *et al.*, 2016), urban ecosystem accounting should aim to provide municipal government with a suite of complementary spatially explicit indicators of accounting values, as well as ecological indicators, welfare economic and socio-cultural indicators of value (Figure 8).

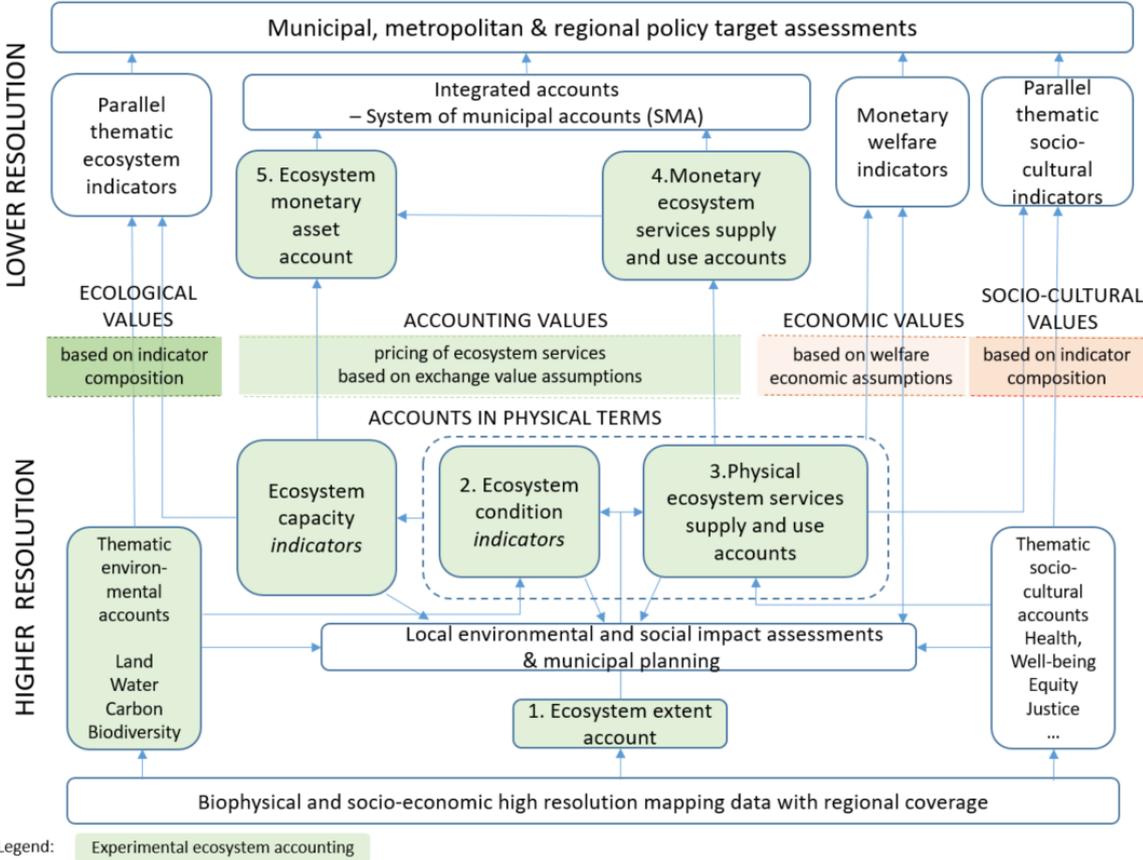


Figure 8 Conceptual framework for urban experimental ecosystem accounting .

Source: based on OpenNESS brief no 5 2017. http://www.openness-project.eu/sites/default/files/Policy%20brief%20%235%20Capturing%20diverse%20nature%20values_Final.pdf

The SEEA EEA extends the production boundary of national accounts, and extends the purposes of national accounting. The majority of the purposes require parallel thematic environmental accounts and indicators of what we may call ecological value (Figure 8). At the same time SEEA EEA TR criteria for selecting accounting monetary values exclude policy relevant information on economic values based on consumer surplus, as well as indicators of socio-cultural values that cannot be valued monetarily. We argue that the stated purpose of SEEA EEA TR to “consider ecosystems through multiple analytical lenses” should include a more systematic treatment of parallel accounts for economic and socio-cultural values as illustrated in Figure 8. Failing to do so risks losing policy relevant information and making ecosystem accounting of lesser importance for municipal level policy.

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